



Technology Focus: Fastening/Joining/Assembly Technologies

Stable, Thermally Conductive Fillers for Bolted Joints

Lyndon B. Johnson Space Center, Houston, Texas

A commercial structural epoxy [Super Koropon (or equivalent)] has been found to be a suitable filler material for bolted joints that are required to have large thermal conductances. The contact area of such a joint can be less than 1 percent of the apparent joint area, the exact value depending on the roughnesses of the mating surfaces. By occupying the valleys between contact peaks, the filler widens the effective cross section for thermal conduction. In comparison with prior thermal joint-filler materials, the present epoxy offers advantages of stability, ease of application, and — as a byproduct of its stability

— lasting protection against corrosion. Moreover, unlike silicone greases that have been used previously, this epoxy does not migrate to contaminate adjacent surfaces. Because this epoxy in its uncured state wets metal joint surfaces and has low viscosity, it readily flows to fill the gaps between the mating surfaces: these characteristics affect the overall thermal conductance of the joint more than does the bulk thermal conductivity of the epoxy, which is not exceptional. The thermal conductances of metal-to-metal joints containing this epoxy were found to range between 5 and 8 times those of unfilled joints.

This work was done by Raymond J. LeVesque II; Cherie A. Jones; and Henry W. Babel of McDonnell Douglas Corp. for Johnson Space Center. Further information is contained in a TSP (see page 1).

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 USC 2457 (f)], to The Boeing Co.

*P.O. Box 2515/MS8WSB43
Seal Beach, CA 90740-1515*

Refer to MSC-23066, volume and number of this NASA Tech Briefs issue, and the page number.

Connecting to Thermocouples With Fewer Lead Wires

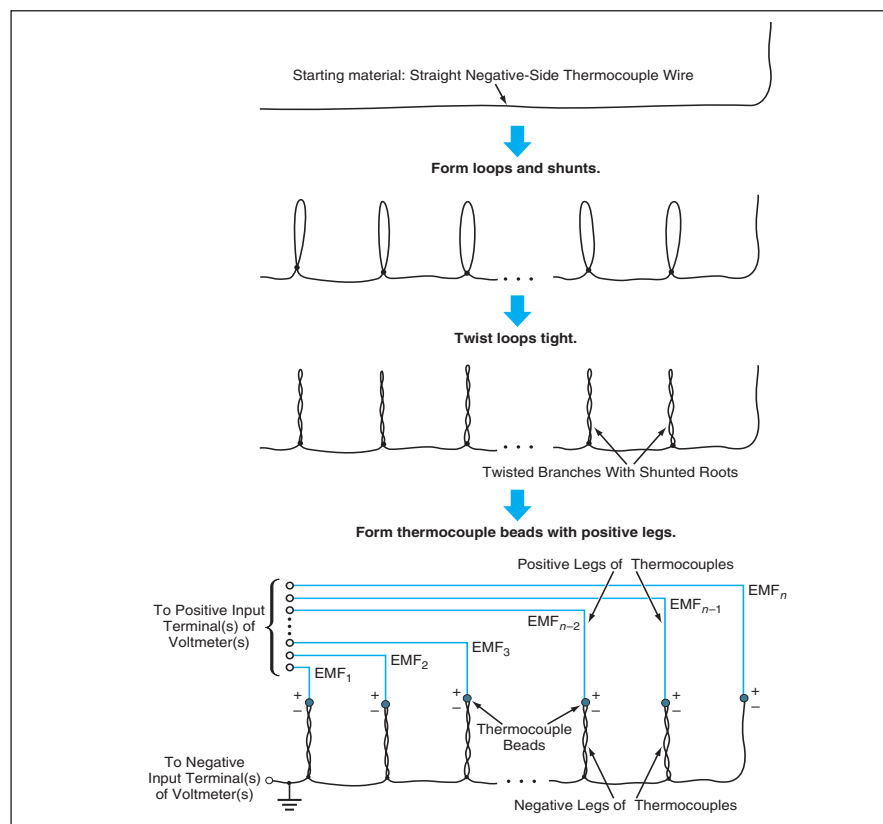
For N thermocouples, only $N + 1$ wires are needed.

John H. Glenn Research Center, Cleveland, Ohio

A simple technique has been devised to reduce the number of lead wires needed to connect an array of thermocouples to the instruments (e.g., voltmeters) used to read their output voltages. Because thermocouple wires are usually made of expensive metal alloys, reducing the number of lead wires can effect a considerable reduction in the cost of such an array. Reducing the number of wires also reduces the number of terminals and the amount of space needed to accommodate the wires.

Heretofore, it has been standard practice to use a separate lead wire to connect to each side of each thermocouple. In other words, it has been standard practice to use $2N$ lead wires to connect to N thermocouples.

The essence of the present technique is to use one common, grounded wire for the negative sides of all the thermocouples in the array and to connect the positive side of each thermocouple, in the customary manner, to the positive terminal of the instrument used to read its output. Fabrication of the array begins with twisting of the single negative-side wire to form branches for thermocouples (see figure). The



A Single Common Wire for the negative sides of N thermocouples is formed into a branched wire. The thermocouples are formed at the tips of the branches.

root of each twisted branch is then heated to shunt the twist, thereby reforming the twisted and untwisted portions of the wire into a continuous piece of branched wire. Next, thermocouples are formed by joining one end of each positive lead wire to the tip of one of the twisted branches and the

other end to one of the output terminals. If the number of thermocouples formed in this way is N , then there are only $N + 1$ lead wires (the one common negative wire and N positive wires) and an equal number of terminals.

This work was done by Jon C. Goldsby of Glenn Research Center. Further

information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17181.

Zipper Connectors for Flexible Electronic Circuits

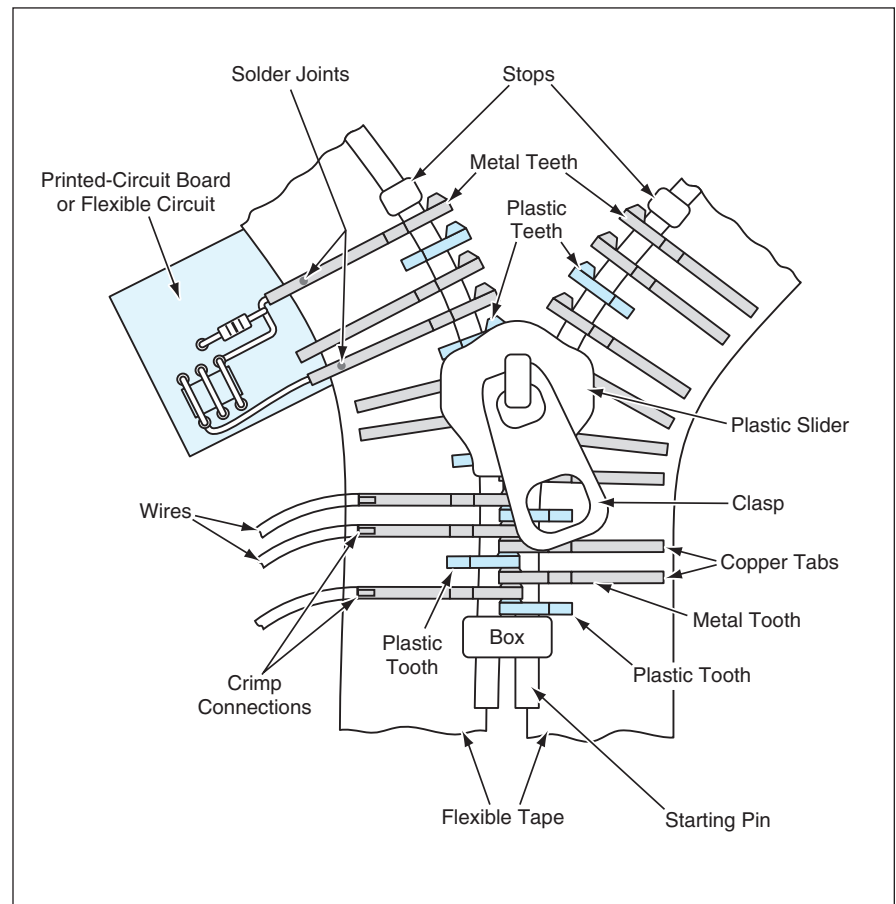
Circuits could be connected and disconnected quickly and easily.

Langley Research Center, Hampton, Virginia

Devices that look and function much like conventional zippers on clothing have been proposed as connectors for flexible electronic circuits. Heretofore, flexible electronic circuits have commonly included rigid connectors like those of conventional rigid electronic circuits. The proposed zipper connectors would make it possible to connect and disconnect flexible circuits quickly and easily. Moreover, the flexibility of zipper connectors would make them more (relative to rigid connectors) compatible with flexible circuits, so that the advantages of flexible circuitry could be realized more fully.

Like a conventional zipper, a zipper according to the proposal would include teeth anchored on flexible tapes, a slider with a loosely attached clasp, a box at one end of the rows of mating teeth, and stops at the opposite ends (see figure). The tapes would be made of a plastic or other dielectric material. On each of the two mating sides of the zipper, metal teeth would alternate with dielectric (plastic) teeth, there being two metal teeth for each plastic one. When the zipper was closed, each metal tooth from one side would be in mechanical and electrical contact with a designated metal tooth from the other side, and these mating metal teeth would be electrically insulated from the next pair of mating metal teeth by an intervening plastic tooth. The metal teeth would be soldered or crimped to copper tabs. Wires or other conductors connected to electronic circuits would be soldered or crimped to the ends of the tabs opposite the teeth.

The pitch (that is, the distance along the zipper between mating pairs of metal teeth) would be a major consideration in design. It has been esti-



A Zipper Connector for electronic circuitry would resemble a conventional clothing zipper in several respects.

mated that a pitch of 100 mils (≈ 2.5 mm) can be achieved by known fabrication techniques and that pitches as small as 25 mils (≈ 0.6 mm) may eventually be achievable. Problems that remain to be solved include how to prevent short-circuiting of exposed teeth in contact with external electrically conductive objects and how to prevent corrosion of the teeth. The short-circuiting problem could be solved by adding a dielectric flap that would

cover the teeth. The corrosion problem might be solved by use of gold contacts; the other option would be to add a water-tight seal, but such a seal could reduce or eliminate the advantage of quick and easy connection and disconnection.

This work was done by Kevin N. Barnes of Langley Research Center. Further information is contained in a TSP (see page 1). LAR-16320